



Functions of the International Agency in Research and Development

J. Robert Oppenheimer

To cite this article: J. Robert Oppenheimer (1947) Functions of the International Agency in Research and Development, *Bulletin of the Atomic Scientists*, 3:7, 173-176, DOI: [10.1080/00963402.1947.11459078](https://doi.org/10.1080/00963402.1947.11459078)

To link to this article: <https://doi.org/10.1080/00963402.1947.11459078>



Published online: 15 Sep 2015.



Submit your article to this journal [↗](#)



Article views: 1



View related articles [↗](#)



Citing articles: 5 [View citing articles](#) [↗](#)

FUNCTIONS OF THE INTERNATIONAL AGENCY IN RESEARCH AND DEVELOPMENT



J. Robert Oppenheimer

The following report is a slightly condensed version of the testimony given by Dr. Oppenheimer before the Control Committee of the UN Atomic Energy Commission on April 29 concerning international research and developmental activities. Dr. Oppenheimer was wartime director of the Los Alamos Laboratory and a member of the committee that prepared the Acheson-Lilienthal Report on the international control of atomic energy. Dr. Oppenheimer, Professor of Physics at California Institute of Technology and at the University of California, is about to assume his new duties as head of the Institute for Advanced Studies at Princeton.

I have read the seven working papers and, by and large, have been very much impressed, not only with the very great elements of agreement, but also with the clarity which permeates them. I think that the problems of research and development are among those where the attack should be most clear and where agreement should be least difficult.

I think everyone has had the experience, when he first inquired into atomic energy, of being rather disappointed that the so-called benign uses, the so-called peaceful uses seemed so extremely vague and so conjectural, and in some cases so remote, compared to the very immediate application in the form of atomic weapons. The reason for this is that, to an extent that is hard to overstate, the peaceful uses of atomic energy are a problem of research and development.

Therefore, it need hardly be emphasized that any attempt to outline what the consequences of such research will be is most misleading, unless it is coupled with a statement that we do not know what the consequences of such research will be.

I would start then by an account of what to me are the visible areas of development, and I will try to give some feeling as to whether they are things which will pay off—which will lead to benefits—in a month or a year or a century. Having done that, I will speak a little of responsibility, of the organic relation which international agencies might appropriately have to these varied fields. In this, I am going to adopt the fundamental principle of *international*

cooperative development of atomic energy. This is a controversial principle which has been argued about, but it seems to me that there has been sufficient agreement on it to warrant pursuing it in this discussion.

SIX FIELDS OF INVESTIGATION

I have listed six fields of investigation—others would make slightly different lists. The first is essentially the use of atomic energy as an instrument of research and development itself. As you know, this field was opened up before the war. The role of atomic energy, in its purely narrow and technical sense of the chain reaction, in making the use of tracers possible, is a limited but very important one. It is limited, because you can make both stable and radioactive tracers by other methods. What the development of reactors has done is essentially to give a limitless supply. In some cases this supply is undigestible. A fission product is manufactured normally in quantities far beyond any that seem to have usefulness in academic or industrial research. I have no doubt that uses will be found; but it is hard to handle hundreds of thousands of curies of material, and it is not clear to me that this will be a great thing for the future. It is clear that in the case of tracers which are hard to make, where the yield is small, and of which the most notable and probably the most fa-

mous example is carbon 14, the availability of these tracers has quite revolutionized the scale of activity.

This is characteristic also of the direct use of radiation which is again not a new thing. Gamma rays and neutrons have been used for allegedly therapeutic purposes for a long time, and some thoughts about their industrial use have occurred to people in the past; but here again the scale has been vastly increased by reactors. These are things which can start paying off in scientific insight, and probably in technical progress, very rapidly.

As for other uses, in physical research, of intense beams of neutrons, I may point out that the very precise measurements of the magnetic moment of the neutron were in fact accomplished using a reactor and that it is doubtful whether a comparably good job could have been done in any other way.

With regard to power, the other great development to which people who try to promote the benign uses of atomic energy usually refer, the situation is different in all respects. It is not an undertaking which is likely to be successful if left to the random efforts of small laboratories.

PROBLEMS OF OPERATING REACTORS

The time scale for it, though controversial, is certainly different from the time scale for the applications of radioactive materials. There are a number of problems which in fact are closely related. There is the problem of operating reactors at temperatures sufficiently high, so that significant power can be produced. This is a complicated problem in chemical engineering, complicated by what radiation does to materials, complicated by questions of heat transfer. This problem was not pursued by us during the war; we do not have a small generator of atomic power turning over a turbo-generator to demonstrate. My own view is that it should not be a matter of many

years before delivering atomic energy in the form of electrical energy will be a proven thing. But that is of course a very small part of the problem. In order to consider using power reactors, let us say, for specialized purposes such as propulsion, and *a fortiori* for general power production, so as to relieve power shortages and to supplement power on the *present scale of world consumption*, you have to worry about the problem of fuel; and the problem of fuel is very largely the problem of making what in the terminology of these Committees is called nuclear fuel. This does not happen overnight. This is something where one can erect from the fundamental constants, Planck's constant, the charge on the electron, and so on, a certain time scale which it will take to produce reasonable quantities of this fuel.

THREE STAGES IN DEVELOPMENT

Therefore, speaking just as a guess, I would give the following estimate of three stages in the development of atomic power, and I assure you that this is not secret information, because there is no secret information as to estimating what the future holds in store.

I think that within five years, and possibly considerably less than that, there will be a demonstration of usable electrical energy derived from nuclear reactors. I think in a decade from now, and certainly in less than two decades, it may be possible to apply nuclear energy to certain specific highly critical problems of energy generation. Whether this will be to establish a station near the north pole, or to propel ships or rockets, I don't know; but it will be a case where cost is not important, where one is willing to divert quite valuable material to a specialized and important objective. I think that it will take between thirty and fifty years before atomic energy can in any substantial way supplement the general power resources of the world.

There are three other areas of activity that I have written down. One is the question of the origins of nuclear energy. I think there is a rather wide-spread belief that the pursuit of fundamental physics is related to atomic energy. It is in

fact so related, but much less directly and much less foreseeably, I think, than is commonly assumed.

EXTENSION OF FRONTIERS OF KNOWLEDGE

I may illustrate the relation, by saying that I think the study of fundamental particles, nuclear forces, the reasons for nuclear stability, the properties of nuclear reactions, and so on, that these things, insofar as they relate to the future, bear to atomic energy about the same relation that the quantum theory does to organic chemistry. This theory is necessary, in order really to understand organic chemistry in terms of physics, but is not necessary in order to have a mastery of organic chemistry quite adequate for the manufacture of TNT and quite adequate for the study of plastics.

These studies of fundamental physics, which are extremely popular among my colleagues in this country, and no doubt abroad, are characteristically things which are conducted in universities, though sometimes in industrial laboratories, and which could be conducted in scientific institutes. They are, as I think was observed in the working paper of the United Kingdom, ideal training grounds for scientists. They correspond to an extension of the frontiers of human knowledge. They may lead, in some way or other, to practical consequences of immense import for the world; that they have a direct bearing on atomic energy is admittedly possible, but I should not predict that it is likely. I do not, in other words, believe in the cosmic ray bombs of which we have read so much in the newspapers.

Here again these are activities which are now going on, which will continue, and of which it is reasonable to expect that they will not be exhausted, at least in our lifetime, and where the prediction of any kind of practical fruit is really beyond even my indiscretion.

There are two other areas. One is the field of atomic explosives. I think that the design of instruments for the delivery of atomic weapons, instruments for the fusing of atomic weapons, of minor improvements in the economy of such weapons, in the way in which they use the material,

and so on, these are things which it is hardly reasonable to have studied, except with war-like intent. I think that the discovery of the possibilities of making atomic explosions, what kind of materials can be used, what principles of assembly can be used, what really goes on in an atomic explosion, these are matters which may need to be studied even in a peaceful world. I believe that very affirmatively, because I think that we do not too fully understand what the limitations and what the possibilities are, and I do not think it is possible to feel confidence in a system of security which leaves unanswered questions which are capable of answer by the proven methods of physical experimentation.

There may be one other argument in favor of such study; it is conceivable—you have all heard it discussed—that atomic explosives may come to be useful for nondestructive purposes. Of course, physically they will always destroy something but they may be used for purposes which are beneficial, such as certain blasting operations or operations for the control of weather, and so on. I do not believe this is a very hopeful avenue of attack, but I do not think that, in any plans for the future, the door should be firmly bolted against exploring these things.

PROBLEMS OF CONTROL AND SAFETY

This brings me to a class of problems which are directed toward purposes of control and safety. Let me give three or four examples. An agency which is worried about the destructive uses of atomic energy will be concerned to see to what extent use can be made of denaturants. I can honestly say that I do not know, and, to the best of my knowledge, none of my colleagues in this country know, how useful denaturants will be—within the rather wide limits of the assertion that they will be of some use, and the certainty that they cannot be all-comprehensive as a scheme of control.

I will give a second example. Everyone knows that in the sun the reactions of light nuclei, notably of hydrogen, give rise to the energy that we live by. Every month or so a man will come around with some scheme for making this energy avail-

able terrestrially. The schemes I have heard are unsound. They will not work. But there is no law of nature that says you cannot make atomic energy on earth out of light nuclei. Therefore, it is necessary to keep open an avenue whereby any sound scheme that is proposed, or any scheme which is not on paper proven unsound, could be explored.

RESPONSIBILITIES OF THE AGENCY

There are other things which tend toward the maintenance of safety. For instance, it has often been suggested that clandestine plants of a certain kind could be detected by the radioactivity that they emit. That wants to be explored. One would want to know whether there are simple methods by which the detonation of an atomic bomb in a remote area can reliably be detected. These are things which any agency that was really worried about maintaining security would want to be free to act upon. It would wish to explore any good suggestions that were made.

It has seemed to me that it would be useful—and here I think my views follow very closely the suggestions in the working paper presented by France—to distinguish three rather different kinds of responsibility that an international agency would have. The first of these is what might be called *primary* responsibility, as in an undertaking without which the agency could not do the other duties with which it was entrusted. The second is *facilitative* responsibility. The third responsibility is a *secondary* and benevolent responsibility, because on the whole it was a very good thing to have this work go on, the agency has an interest in it, but does not live and die by it.

I think these distinctions will become clearer by example. With the exception of its responsibility for control, the only thing which an agency dedicated to international development of atomic energy has to do now lies in the field of research and development. That is an overstatement. It does have to do some other things. It has to mine some uranium, look into the future, and so on; but the peaceful uses of atomic energy are coextensive with research and development.

If one takes these words with the kind of seriousness that the situation warrants, I would say that the international agency would have a primary responsibility for the development of reactors, for the methods of producing nuclear fuels. Here my own view would be that, in the long-term, the reactors themselves would be the most effective instruments for doing this, but that separation plants would play a necessary, if not major, part. The agency would have such responsibility for the discovery, exploitation, and recovery of raw materials, for the problems that I mentioned above, having to do with safety, and with devices that can be used to render more or less likely the diversion of material to destructive ends, and for an understanding of atomic explosives.

When I say “primary responsibility”, I do *not* mean by that that the international agency should forbid others to participate in this work. We will talk of that briefly later. But it should see that the work gets done and should by all means directly engage in the work, in laboratories of its own. Such laboratories are going to be large undertakings. They are going to be patterned after the typical wartime laboratory, which was mostly a place where development was carried out. They are going to be not too dissimilar from what in this country is a rather common pattern of industrial laboratory. They are not going to be very much like the academic laboratory in which fundamental physics, chemistry, and biology have in the past been pursued.

THE FACILITY LABORATORY

Quite different is the style of the facility laboratory, the laboratory which is built and perhaps operated by the agency, but with the purpose of being useful to people outside the agency and with the purpose of making available facilities and techniques developed by the agency. A small reactor is in this category. Here I would not wish to insist that it be operated by the agency. That does not seem to me to be terribly important. It must at least be licensed, and it needs to be brought into existence by the agency.

The agency must be responsible for seeing that such facilities are available where there are people to make use of them. Here a very much greater degree of dispersion is probably desirable. Here the pattern should probably be laboratories of quite moderate size and not very programmatic; that is, anyone who comes in and says “I want to radiate this” should get permission, provided “this” is not something that will blow the place up and provided he is a competent scientist. These laboratories should be free laboratories in which the agency’s great role is that it can facilitate the pursuit of scientific and technical matters.

VALUE OF UNPREDICTABLE FINDINGS

In the third category, by way of example, I think it might be very desirable for the international agency to have a great synchrotron or synchro-cyclotron. However, this is certainly a field in which it does not have a primary involvement. This is a great field in which men and women work in a rather badly organized manner, as scientists usually do, in institutes and universities; men and women who get up late and do not quite know what they are going to do tomorrow unless they do have a bright idea, in which they will work as they have in the past and from which essentially unpredictable findings about the natural world will emerge.

That goes for physics; it goes for chemistry; it goes for biology; and it goes for all those fields which have contact with atomic energy but in which that contact is only a very small part of the field. Atomic energy is a small part of science; it is only a very big problem in the contemporary world.

As was mentioned in the memorandum of the United Kingdom, I share the view that these three kinds of activities probably should not be mixed to too great an extent. What you run into when you mix developmental activities, which are programmed, planned and focused, with activities which are of an inquiring and scientific nature, is the rivalry of two incompatible snobisms.

The scientist is irritated by the practical preoccupations of the man concerned with development, and the

man concerned with development thinks that the scientist is lazy and of no account and is not doing a real job anyway. Therefore, the laboratory very soon gets to be all one thing or all the other. I remember that Dr. Fermi came to Los Alamos some time after the foundation of the laboratory. He was somewhat horrified when he came to me and said, "The people here are actually interested in developing atomic weapons." That indicated the triumph of the engineer's view over that of the scientist.

THREE FIELDS FOR MONOPOLY

Of all these things, there are, to my way of thinking, only three where I would feel that a provision for monopoly by the international agency, as opposed to the privilege to pursue and instruction to pursue, might appropriately be written into the paper setting up the agency. Two are in the fields of atomic explosives and in those parts of reactor development which use a large amount of explosive or potentially explosive material. My belief is that the reactor development of the future will involve large amounts of nuclear fuel, amounts so large that their diversion would in itself constitute a military menace, perhaps not a major menace but a disagreeable menace.

These two things and a third, which I would add as a possibility but not a mandate, would be the only fields of monopoly. As every one knows, the third is that fission products can be used as poisons. I do not know whether this is a very effective form of warfare. However, the exploration of the potentialities here might well be left an international monopoly. Certainly, it is something which should not be facilitated by the international agency as a national activity. One would not want the international agency to say, "Here are a million curies of radio-barium. See how many people you can poison with it."

I think that the prominence that has been given to the matter of atomic explosives, in what has been written about it, gives quite a wrong view of its importance. I think one or two laboratories poking around on the question of the fundamentals of atomic explosives, trying out notions of how you might use a certain dena-

tured material and prove that it would explode, would probably be all that would be involved.

There may be a period of a decade where an international agency might say of this field, "There is not anything to do; nobody has any ideas and we are not interested in improving the efficiency of atomic explosions by five per cent." However, I think that provisions should be made to make such studies possible; and provisions should surely be made to forbid them to national agencies, because they are certainly useful in the hands of national agencies only in the measure in which they may be used in warfare.

I would add to that—and here I am differing from the United States' working paper, but I believe in a legitimate way—it does not seem to me very profitable to forbid thinking about atomic explosives. This is something the prohibition of which may be rather hard to enforce. I believe, therefore, that the prohibition should be limited to those activities which require the possession of significant quantities of nuclear fuel for being carried out, because, if the international agency is good, if it is any good, it will know where the nuclear fuel is and it will know what is happening to it. Controls which are determined by this physical instrument—namely, where the material is—are certainly enforceable, if anything is.

I do not think that general staffs can be prevented from brooding about targets to bombard, carriers to carry the bombs, fuses, or anything like that; and I would hesitate to do more than to implore them not to engage in this activity. I would hesitate to prohibit them from engaging in this activity.

SCALE OF RESEARCH AND DEVELOPMENT

I should now like to comment as to the scale of this whole activity of atomic research and development. I think the work of the development authority might, when it was flourishing, take some ten per cent of the physicists and chemists, perhaps five per cent of the chemical engineers, and perhaps five per cent of the mining engineers there are in the world.

There ought to be several programmatic laboratories, several meaning not one or two and not one

hundred but something of the order of a half-dozen perhaps, which would give a reasonable dispersion and yet make possible rather large laboratories in which coordinated effort would be carried on . . . Furthermore, it is important to emphasize that there should be openness, not only among these laboratories but also between these laboratories and all other laboratories of the agency, and all private, university, academic, national, and institutional laboratories. There should be complete and absolute openness.

SECRET KNOWLEDGE

IS DANGEROUS

I also extend this to the problem of atomic explosives. Knowledge about atomic explosives is, in a situation such as we are here contemplating, more dangerous if not disseminated than it is if disseminated. The possibilities of keeping secrets in this field are in any case so remote, if one has an international undertaking, that one should plan for a systematic program of dissemination and education.

I have a word to say about this; namely, that it is not enough to declare something is open. It requires instruction; it requires work to get an understanding of these things abroad. I know this from experience. I know it is not enough to tell someone a secret; it is very hard to give away a secret. You have to work at it week after week after week because these things are complex. Only the creation of a really widespread and informed understanding of the techniques of atomic energy will get work on these problems advanced rapidly and with full effectiveness.

Let me explain that. The normal way in which progress is made in any of these developmental activities is that people become excited by the problem. They read about it some place; they talk about it; they have an idea and they come and say they would like to work on it. In order to further that goal, people who are not working on the problem, on the specific problem, must have a way of finding out about it. That is, they must have access to information before there is any foreseeable chance that they will make good use of the information.

(Continued on Page 197)

Functions of the International Agency

(Continued from Page 176)

It is my feeling that the agency, if it is set up, must devote itself to the cultivation of this understanding, so that the whole pool of scientists and engineers in the world will be available. Only a small fraction of them would actually participate in the work. Nevertheless, those who participate in the work should be the ones who are interested in it and have learned about it before they could prove that their learning about it would pay off.

I belabor this point because it is, to my way of thinking, the decisive reason why the development of the peaceful uses of atomic energy will prosper more under a system of international cooperation, and corresponding openness, than it possibly can under purely national systems.

Under purely national systems, vast areas will remain secret. It is true that various nations may all be keeping the same secrets from each other, but they will keep them. As a result of that, the spontaneous growth and development—which is the thing that has always in the past enriched our lives through scientific discovery—will be enormously slowed down. It will not be stopped. I do not know that my time scales for atomic power are too far off even under national development, but they are certainly too short for national development and deliberately conservatively long for international development.

There are other reasons. The distraction of atomic armament is a real distraction. But these are secondary reasons compared to the enormous advantage of allowing the imagination and spontaneous interest of men to carry out this development, as it would under such conditions of international cooperation and openness.

I would make only two further comments: there is in the proposal for international cooperative development, insofar as it is a job of research and development, very little that is contrary to past patterns of scientists and technical people all over the world. It is a pattern recognized by all of us. Just for that reason, this part of the job of international control is an easy part; in this part, one can be quite confident of success.

A Letter to the Editors

IMPORTANT OMISSION IN ACCOUNT OF WORLD GOVERNMENT

I have just read in your June issue the article, "The World Government Movement in the United States," by Mr. Harrison Brown. In the article Mr. Brown discusses the movement at some length and ends by listing and describing world government organizations. In both he fails to mention Federal Union.

His only reference to the Federal Union movement is to say that "advocates of Russian exclusion from such a government, including former Associate Justice Owen J. Roberts and Clarence Streit (formerly leader of the Union Now movement), divorced themselves from the groups listed above at an early date."

The fact is that Federal Union, Inc., was founded in 1939 to unite free people by world government and has never changed that policy. It is not based on a negative policy of excluding Russia, but on a positive policy of uniting free nations until the attraction of this free union brings all nations of the world into a democratic federal world government. Mr. Streit is still leader of the Union Now movement which is Federal Union. Advocates of this movement did not divorce themselves from the groups which Mr. Brown lists; the reverse is true, two of the three organizations Brown mentions being

The last comment is this:

Although the primary purpose of the United States proposals is to provide security, rather than to provide freedom of research, this freedom is nevertheless a criterion by which their fundamental soundness may be judged; for no proposals predicated on forbidding enquiry and learning could, in the end, survive.



first formed as splinter groups breaking away from Federal Union.

Mr. Brown and some of his colleagues seek to minimize Federal Union by ignoring it. Yet this organization has done more by sustained effort to stimulate the desire for world government than any of the four organizations Mr. Brown lists at the end . . .

It is significant that in the same issue of your publication in which Mr. Brown discussed the "world government movement" while conveniently ignoring Federal Union, Dr. Harold C. Urey in the lead article calls for a federal union of democratic nations as the first step toward democratic world government. This is exactly the Federal Union program . . .

—Don Dennis
Executive Director,
Federal Union Inc.

I would like to apologize to Federal Union for overlooking their organization in my article surveying world government groups. Contrary to the belief expressed by Mr. Dennis, the omission was not premeditated, nor was it my intention to "minimize Federal Union by ignoring it". The fact of the matter is that I have long admired the unselfish vigor with which Mr. Streit has carried on his program of education concerning the need for federation.

When the editors of the BULLETIN requested that I write an article describing "which organization is which" in world government circles, I accepted reluctantly, realizing that the history of the various organizations is so complicated, I might easily offend some groups and find myself in a delicate position. Apparently, I was right.

Perhaps the omission occurred because I have always subconsciously thought Federal Union leaders to be vigorous in their belief that a government should be formed either directly or indirectly excluding Russia until she is democratized. A government that does not include Russia is not a "world" government. Likewise, I did not believe, until Mr. Dennis indicated my error, that a group fighting for such a partial government considered itself to be a world government organization. I apologize.

—Harrison Brown